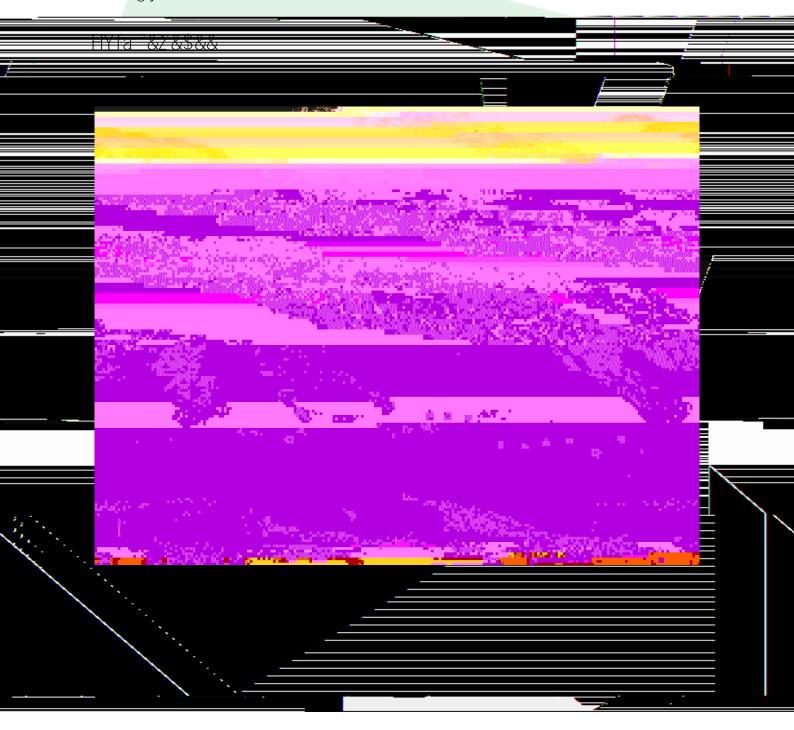


# **EDST5138**

±bWig]jY'9XiWUh]cb.'Dc`]Whž'D`Ubb]b['UbX'DYXU[c[m



# 7ci fgY<sup>·</sup>Cj Yfj ]Yk

# GhJZZ 7 cbhJWh 8 YhJ] `g

# 7cbj Ybcfg

BUa Y	9a U]`	5j U]`UV]`]hm	@cWUh]cb	D\cbY
8 f 7 Ufc ]bY 6 UgW_]b	WWUgW]b4 i bgk "YXi "Ui	6mUddc]bha Ybh		

#### 5W\_bck `YX[ Ya YbhcZ7ci bhfm

I BGK '5frgž8Yg][ b'UbX'5fW,]hYWi fY'? Ybg]b[ hcb'UbX'DUXX]b[ hcb'Wa di gYg'UfY'Vi ]'hcb'5Vcf][ ]bU`@UbXg"'K Y'dUmci f'fYgdYWg'hc'h,Y'6]X'][ U''UbX'; UX][ U''dYcd'Yg'k \c'UfY'h,Y'7 i ghcX]Ubg'cZh,YgY'`UbXg" K Y'UW\_bck `YX[ Y'h,Y'5Vcf][ ]bU`'UbX'HcffYg'GhfU]h=g`UbXYf'dYcd'Ygž'h,Y': ]fghi5i ghfU`]Ubgžk \cgY'`UbXgž k ]bXg'UbX'k UhYfg'k Y'U``'bck 'g\UfYž'UbX'dUmfYgdYWhc'h,Y]f'i b]ei Y'j U'i Ygž'UbX'h,Y]f'Wbh]bi ]b[ 'UbX YbXi f]b[ 'W' h fYg'k \]W. XYYYdYb'UbX'Ybf]W. h,Y'`]ZY'cZci f'bUh]cb'UbX'Wca a i b]h]Yg"''

 $\label{eq:continuous} $$ = U[Y'WciftYgmcZthY'CZthY'Dfc'J]WY!7\UbWY``cf'+bX][Ybcig'] $$ BGK $$ fig'+bX][Ybcig'ghfUtY[m] $$ $$ Fight = Fig. $$ fig'+bX][Ybcig'ghfUtY[m] $$ Fig. $$ Fig$ 

### 7ci fgY 8YHJ] g

#### $I b h c Z 7 f Y X h^*$

K cf\_`cUX

%) \$`\ci fg`]bWi X]b[`WUgg`WcbHUWh\ci fgž`fYUX]b[gž`WUgg`dfYdUfUh]cbž`UggYgga Ybhž`Zc``ck`i d`UWhjj]h]Ygž YhW

#### Giaa UfmcZh\Y 7ci fgY

H\]g`Wci fgY`k]``dfcj]XY`Ub`cjYfj]Yk`cZh\Y`df]bW]d`Ygždc`]W]YgžUbX`d\]`cgcd\]Yg`i bXYfd]bb]b[`]bWi g]cb" H\Y`I b]j YfgU``8Yg][ b`Zcf`@YUfb]b[`UddfcUW\`hc`W ff]W``i a `XYg][ b`Zcf`ghi XYbhg`k]h\`X]gUV]`]h]Yg`cf`X]j YfgY bYYXg`k]```VY`U`WYbhfU``ZcW g`Ug`kY``Ug'Yj]XYbWY`UbX`fYgYUfW\!VUgYX`UddfcUW\Yg`hc`hYUW\]b[`h\YgY ghi XYbhg`]b`a U]bghfYUa `gW\cc``gYhf]b[g"`H\Y`fc`Y`cZhYUW\YfgžgdYV]U``YXi WUhcfgž'UbX`h\Y``YUXYfg\]d`hYUa ]b`dfca ch]b[`h\Ygi WWggZ\``]bWi g]cb`cZghi XYbhg`k]h\`X]j YfgY`bYYXg`k]```U`gc`VY`\][\`][\hYX"

#### 7 ci fgY @YUfb]b[ Ci hWca Yg

%" 8 ]gW gg 'h\ Y 'dfYj U]`]b[ 'Ulh]h XYg 'hck UfXg 'dYcd`Y 'k ]h\ 'X]gUV]`]hm'

- &" 5dd`m\_bck `YX[Y`cZ`Y[]g`Uh]cb`UbX`[cjYfbaYbhdc`]W]Yg`fY`UhYX`hc`h\Y`YXiWUh]cb`UbX`]bWig]cb`cZdYcd`Y`k]h\`X]qUV]`]h]Yg`iq]b[`dfcZYqq]cbU``^X[aYbhUbX`WiffYbhfYqYUfW\"
- ' " 9 I d`U]b`\_YmhYfa g`fY`UhYX`hc`X]gUV]`]hmUbX`]bWi g]cbž'UbX`UfhJWi`UhY`h\Y`WiffYbh]ggi Yg`UbX`hfYbXg |b`h\Y`]bWi q]cb`cZghi XYbhg`k ]h\`X]gUV]`]hm"
- ("5X1ghW ff]W i a 'j ]U a cX]Z]WUh]cb cf UVWca a cXUh]cbg hc Ugg]ghghi XYbhg k ]h\ X]gUV]`]hmhc a YYh YXi WUh]cbU`ci hWca Yg"

### HYUWX]b[ GhfUhY[]Yg

#### FUhjcbU`Y`UbX`hYUVX]b[ 'ghfUhY[]Yg

]b"h\Y"Z|bU`"UggYgga Ybh'hUg\_"

 $\label{eq:hamiltonian} $$HYgY^*UW^*_{jj} = \frac{1}{2}Y^*C^*UW^*f^*_{jb}^*U^*W^*_{ja} = \frac{1}{2}Y^*C^*UW^*_{ja}^* = \frac{1}{2}Y^*C^*UW^$ 

## 5ggYgga Ybh

5ggYgga Ybh'hUg_	K Y][ \h	8iY'8UHY	7 ci fgY @YUfb]b[ Ci hWca Yg 5ggYggYX
%".7 cb\\\dh\XYa cbglfUljcb	(\$1	&(#\$*#&\$&&`\$).\$\$`DA	&ž¨ ž˙(
&"`I8@]gYX``Yggcb`d`Ubg	*\$1	UŁŚ(#\$+#&\$&&).\$\$DA/VŁ %/#\$+#&\$&&).\$\$DA/WŁ \$(#\$,#&\$&&).\$\$DA	%ž' ž'(

### 5ggYgga Ybh% 7cbWdhXYa cbghfUh]cb

8i Y`XUhY.`&(#\$\*#&\$&&`\$).\$\$`DA

&) \$\$"k cfXg

Gh XYbhg k ]``fYWr]j Y k f]hh b#Ji X]c ZYYXVUW\_ k ]h\]b '%\$ XUmg cZgi Va ]gg]cb

#### 5XX]h]cbU`XYhJ]`g

I b]j YfgU``8Yg][ b`Zcf`@YUfb]b[ 'WcbWdhXYa cbglfUh]cb"

Ghi XYbhgʻk ]h\ X]j YfgY``YUfb]b[ 'bYYXgʻ]b`]bWi g]j Y`WUggfcca gʻfYei ]fY`hYUW\YfgʻhcʻYa d`cmYZYWij Y hYUW\]b[ 'a Yh\cXgʻhcʻYbgi fY`h\YʻfYei ]fYX`WcbhYbh]gʻUWWgg]V`Y`Zcf`U```ghi XYbhg"`I g]b[ 'fYWYbhmdi V`]g\YX f&\$%&!&\$&&L`fYgYUfW\``]hYfUhi fY`cb`I b]j YfgU``8Yg][ b`Zcf`@YUfb]b[.`fULXYa cbghfUhY`m dYYf'fYj ]Yk 'UbX'Wca a Ybh' &X]WUhY k \Uh [ fUXY#YUfbYfg']hk ]``VY'Zcf"'H\]g']g'U'\i fX`Y'fYei ]fYa Ybh' \$5ggYgga Ybh'&V. 'DYYf'ZYYXVUW\_

FI 6F = 7 # 998657? 'G<99H 98GH)%, 'B7@I G = 9'98I 75H € B. 'DC@=7 M2'D@5BBB; '5B8

D985; C; M

I BGK G7<CC@C: 98I 75H€B

GdYWJZJW7f]hYf]U	∵flŁ—		 2f <b>Ž</b> Ł
7 `Uf]mž Wcbg]ghYbWnž UbX `Uddfcdf]UhYbYgg `cZ k f]n]b[ #Mca a i b]WUn]cb `Wcbj Ybh]cbg `]bWi X]b[ `gYbhYbWY ghfi Whi fYž'j cWUVi `Ufmi gYž'gdY``]b[ ž'UbX di bWhi Uh]cb			

FI 6F = 7 # 998657? G < 99H

98GH)%, ₽7@ G = 998175H € B. DC @=7 M2D@5BB ₽; 5B8

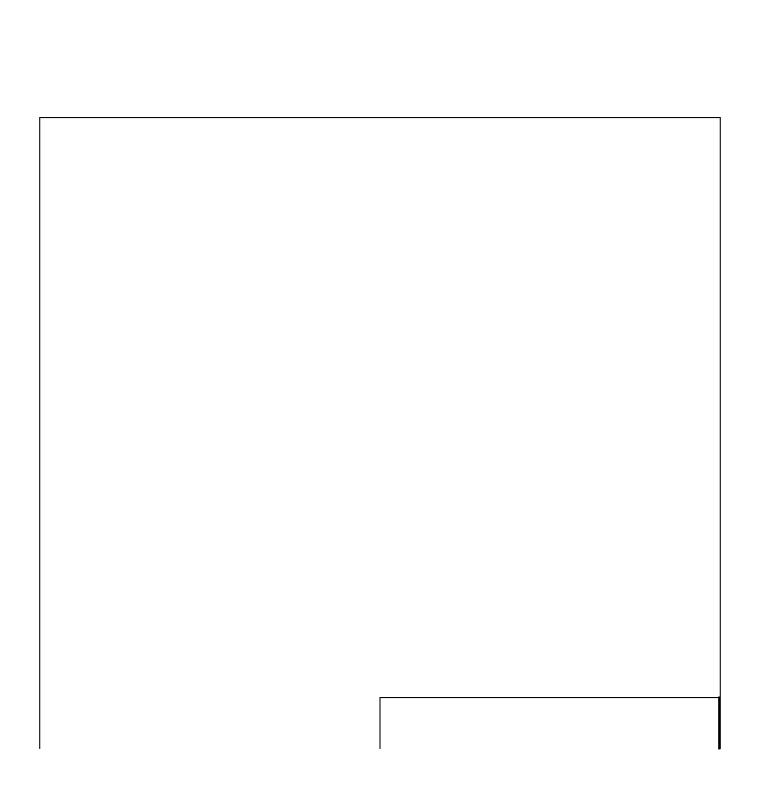
D985; C; M

I BGK 'G7<CC@'C: '98I 75H€B

5ggYgga Ybh'HUg\_'& I 8@]gYX "Yggcb'd Ubg

GdYWJZJW7 f]hYf]U	···flŁ—		2fŽŁ
I bXYfghUbX]b[ 'cZh\Y'ei Ygh]cb'cf']ggi Y'UbX'h\Y'_YmWcbWfdhg ] <b>b</b> jj ©`jjYYX <99H			

GdYWJZJW7f]hYf]U	"flŁ—	 	 2fŽŁ
]bWi XYX`UbX`UggYgga Ybha Yh\cXgŁ			
• Ga Ufh[cU`g`]bWi XYX`]b``Yggcbgž'Ug`k Y```Ug`X]ZZYfYbh]UhYX`[cU`			



# FYgci fWYg

# DfYgWf]VYX F Ygci fWYg

DfYgWf]VYX hYI h

; Uf[]i `cžF"ž/ `A YhWU`Zž8"'f&\$%+Ł"' VRTYZ\_X Z\_ e URj d Z\_T]fdZgV T]Rddc` ` ^ dž3 f\_ZgVcdR] UVdZX\_ Wc ]VRc\_Z\_X Raac` RTY

### Gi Va ]gg]cb cZ5ggYgga YbhHUg\_g

### Hi fb]h]b Gi Va ]gg]cb

Image: Ybwci bhYf'U'dfcV'Ya k \Yb'UhYa dhjb['hc'gi Va ]hmci f'Ugg][ ba Ybhh\fci [\'Hi fb]h]bz'd'YUgY

HY'Yd\cbY'9| hYfbU''Gi ddcfhcb'-', ) "''' %cf'Ya U]''h\Ya 'cb'Y! hYfbU'hY'hgi ddcfh4 i bgk "YXi "Ui ""Gi ddcfh
\ci fg'UfY', .\$\$Ua '-'%\$.\$\$da 'cb'k YY\_XUmg'UbX'-.\$\$Ua '-').\$\$da 'cb'k YY\_YbXg'fl \*) 'XUmg'U'mYUft'''=\mathred{Image: Wa Jhmci f'Ugg][ ba YbhXi Y'hc'U'ZJi 'hk ]h\'Hi fb]h]b'mci 'a UmUdd'm\mathred{Image: Wa Jhmci f'Ugg][ ba YbhXi Y'hc'U'ZJi 'hk ]h\'Hi fb]h]b'mci 'a UmUdd'm\mathred{Image: Wa Jhmci f'Ugg][ ba YbhXi Y'hc'U'ZJi 'hk ]h\'Hi fb]h]b'mci 'a UmUdd'm\mathred{Image: Wa Jhmci f'Ub'Y! hYbg]cb\mathred{Image: Wa Jhmci h\Yf'f'Y'j UbhXcW a Ybhg\mathred{Image: Wa Uj''9! hYfbU''Gi ddcfhmci 'k ]'`

JbWi XY'Ug'Yj ]XYbW' hc'gi ddcfhmci f'Y! hYbg]cb'Udd']\wUh]cb"'\mathred{Image: Wa Uj''9! hYfbU''Gi ddcfhmci 'k ]'`

Ui hca Uh]\wU'`mfYW']j Y'U'h]\w\_Yhbi a VYf\mathred{Image: hY'Yd\cbY'mci 'k ]\tag{Y}\wu''mug\_'\mathred{Image: Wa'\mathred{Image: hY}\wu''mug\_'\mathred{Image: hY}\wu''mug\_'\mathred{Image: hY}\wu''mug\_'\mathred{Image: hY'Yd\cbY''mci 'k ]\tag{Y}\wu''mug\_'\mathred{Image: hY'\mathred{Image: hY'\mathred{I

; YbYfU``mž'UggYgga YbhiHug\_g'a i ghVY'gi Va ]hhYX'Y`YVWfcb]\W)``mij ]U'Y]h\Yf'Hi fb]h]b'cf'U'A ccX`Y Ugg][ ba Ybh'' =b']bgHJb\W'g'k \YfY'h\]g']g'bchdcgg]V`Yž']hk ]```VY'gHJhYX'cb'mci f'\\circ i fgY'g'A ccX`Y'g]hY'k ]h\U`hYfbUhjj Y'gi Va ]gg]cb'XYHJ]`g''

cfi]bZcfa Uhjcbicbi\ckihcigi Va ]hUgg][ ba Ybhgicbi]bYij ]UiA ccXiY.i\hdg.#gh XYbhi bgk "YXi "Ui #\ck! gi Va ]hUgg][ ba Ybha ccXiY

### 5 WUXYa ]W<cbYghmUbX D`U[ ]Uf]ga

D`U[]Uf]ga i]gii g]b[ih\Yik cfXgicfi]XYUgicZch\YfgiUbXidfYgYbh]b[ih\Ya iUgimci fick b"i=hWbihU\_Yia Ubm Zcfa qžZfca iXYi]VYfUhYiWXYUh]b[ihciUWW]XYbhU`mWcdm]b[iZfca iUiqci fWYk]h\ci hUW bck iYX[Ya Ybh'

IBGK [fcidgdu[]Uf]ga ]bhch\YZc``ck]b[WUhY[cf]Yg.

7 cdm]b[. `I g]b[ 'h\Y'gUa Y'cf'j Yfmg]a ]`Uf'k cfXg'hc'h\Y'cf][ ]bU`'hYl hcf']XYU'k ]h\ci hUW\_bck `YX[ ]b[ 'h\Y gci fW'cf'i g]b[ 'ei chUh]cb'a Uf\_g"'H\]g']bWi XYg'Wcdm]b[ 'a UhYf]U`gž']XYUg'cf'WcbW'dhg'Zfca 'U'Vcc\_ž'Ufh]WYž fYdcfhcf'ch\Yf'k f]hhYb XcW a Ybhz'dfYgYbhUh]cbž'Wca dcg]h]cbž'Uffk cf\_ž'XYg][ bž'XfUk ]b[ ž'WfW ]hfmž'Wca di hYf dfc[ fUa 'cf'gcZk UfYž'k YVg]hYž']bhYfbYhz'ch\Yf'Y`YWfcb]WfYgci fW'z'cf'Ubch\Yf'dYfgcbfg'Ugg][ ba Ybhk ]h\ci h Uddfcdf]UhY'UW\_bck `YX[ Ya Ybh''

**Duddfcdf]UhY dufud\fug]b**[...7\ub[]b[...12\k...k.cfXg.UbX.d\fugYg.k.\]Y a cghmfYhJ]b]b[...h\Y.cf][]bU`]bZcfa Uh]cbžghfi Wh fY UbX#cfdfc[fYgg]cb.cZ]XYUg.cZh\Y.cf][]bU`k]h\ci hUW\_bck `YX[Ya Ybh'.H\]g.U`gc Udd`]Yg.]b`dfYgYbhUh]cbg`k \YfY gca YcbY dufUd\fugYg.Ubch\Yf'g.]XYUg.cf`k cfXg`k]h\ci h`WfYX]h`UbX`hc d]YW]b[...hc[Yh\Yf'ei chYg.UbX.dUfUd\fugYg.]bhc.U`bYk `k\c`Yžk]h\ci h`Uddfcdf]UhY`fYZYfYbW]b[...hc]

7c``i g]cb. K cf\_]b[ k ]h ch\Yfg'Vi hdUgg]b[ cZh\Yk cf\_'Ug'U'dYfgcb'g']bX]j ]Xi U``k cf\_"'7c``i g]cb'U`gc ]bWi XYg'dfcj ]X]b[ 'mci f'k cf\_'hc'Ubch\Yf'ghi XYbhZcf'h\Y'di fdcgY'cZh\Ya 'd`U[ ]Uf]g]b[ ždUm]b[ 'Ubch\Yf'dYfgcb'hc'dYfZcfa 'Ub'UWUXYa ]Whuq\_ž'ghYU`]b[ 'cf'UWei ]f]b[ 'Ubch\Yf'dYfgcb'g'UWUXYa ]Wk cf\_'UbX'Wcdm]b[

## 5 WUXYa ]W + DZcfa Uh]cb

8 i Y 'hc 'Yj c'j ]b[ 'UXj ]WY 'VmBGK '< YU'h\  $\check{z}$ ghi XYbhg'a i gh\W\Y\W\_'\Zcf'i d\X\Uh\Y\X']b\Zcfa \Uh\cb'fY[\Uf\X]b[ 'cb\]bY 'Y\Ufb]b[ 'Zcf'\U\`'5fhg\{z}8\Yg][\b'\Ub\X'5f\W\]h\Y\Wi\fY'\Wci\fg\Yg'\h\]g'\h\fa\'fJ\]U'\A\cc\X'\Y'\cf'\Wci\fg\Y']b\Zcfa\Uh\cb\dfcj ]\XY\X''\L

: cf`YggYbhJU``gh XYbh`]bZcfa UhJcb`fY`UhJb[ 'hc.

- fYei YghgʻZcfʻYl hYbg]cb/
- `UhY gi Va ]gg]cbg [ i ]XY`]bYg/
- fYj ]Yk 'cZa Uf\_g/
- I BGK '< YU`h\ 'UbX'GUZYhm'dc`]W]Yg/
- YI Ua ]bUh]cb dfcWYXi fYg/

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